FY2002 NOAA and USGS Coral Reef Initiatives

As prescribed by the U.S. Coral Reef Task Force, the Coral Reef Monitoring Program has as its goal the full utilization of in-situ and space-based observations to monitor for early indications of climate change-induced coral reef bleaching worldwide on a continuing basis. A major objective is to be able to understand the relationship between the magnitude and persistence of anomalously high sea surface temperatures in coral reef areas and subsequent reef mortality risks. Expansion of the Coral Reef Early Warning System (CREWS) network and linking it to research on reef ecosystems will require collaboration between NOAA, USGS, and NPS personnel from domestic reef jurisdictions.

BACKGROUND. Coral reefs worldwide are deteriorating. Natural stresses like hurricanes as well as coral diseases and factors associated with detrimental human activities, such as overfishing, anchor damage, boat groundings, and increased sedimentation and nutrient run-off from upland development play a role. In general, reef-building organisms, such as corals, are declining while non-reef-building organisms, such as algae, are increasing. This trend is evident even within marine protected areas (MPAs) such as national parks and marine sanctuaries.

Figure 1. *Excessive sea surface temperatures can lead to coral reef ecosystem stress and eventual coral bleaching and mortality*

In response to this crisis, the President's Executive Order on Coral Reefs (1998) and the National Action Plan to Conserve Coral Reefs (adopted in 2000) called for increased research and monitoring on these ecosystems. Since 1995, NOAA has been at the forefront in utilizing sea surface temperatures from space-based observing systems to provide early warnings of climate warming-induced coral reef bleaching. NOAA's Coral Reef Early Warning System (CREWS) extends these predictive capabilities through ground-truth measurements. The USGS also has long provided ground based biological monitoring and research capabilities to ascertain coral reef ecosystem trends in Hawaii, Florida and the Virgin Islands. NOAA and USGS propose to combine their efforts in studies of reefs in the Pacific, Atlantic, and Caribbean.

STATUS. The emerging recognition that coral reefs might be the *"canary in the coal mine,"* that is, an early indicator of global warming, led NOAA to explore ways to improve global monitoring of coral reef ecosystems. They established and continue to develop a research program to utilize NOAA's satellite-derived sea surface temperature (SST) data in the automated synthesis of "HotSpot" and "Degree Heating Week" analysis charts, as well as "Tropical Ocean Coral Reef Bleaching Indices." The NOAA CREWS effort was developed for the automated *in situ* monitoring and modeling of conditions conducive to coral bleaching, such as high sea temperatures and high intensity sunlight. The USGS coral reef research program utilizes digital video monitoring to quantify coral and algal abundances, to detect changes over time, and to monitor the influence of anthropogenic pollution. In Florida and Hawaii, the USGS has been using their Submersible Habitat for Analyzing Reef Quality (SHARQ) to monitor geochemistry for calculation of coral calcification and production rates.

NOAA and USGS efforts complement each other. USGS provides ecological data on changes in reef systems for correlation with data from NOAA satellite Sea Surface Temperature and CREWS stations. These two agencies now have the opportunity to collaborate in an effort to determine both sources of reef degradation, as well as the utility of SST for monitoring coral reef bleaching.

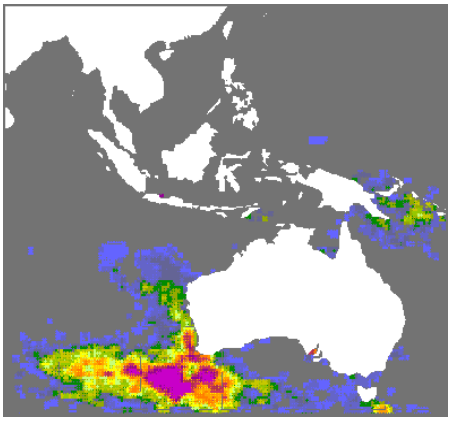

Figure 2. *NOAA satellite-based coral reef Degree Heating Week analyses (yellow to red areas shown above for Feb 16, 2000) – shows high thermal stress accumulations*

PLANS. NOAA and USGS propose a joint large-scale study of the structure and function of reefs in Hawaii, Florida and the US Virgin Islands. NOAA will increase its remote sensing monitoring using satellite and CREWS activities in the target regions. The USGS will provide the needed field verification by increasing monitoring and reef-based research at the same locations.

Figure 3. *CREWS meteorological and oceanographic monitoring station*

To this end, NOAA proposes to add nutrient, pCO_2 and possibly other pollutant indicator sensors on newly deployed and future NOAA CREWS stations. NOAA's CREWS stations will then provide data on a suite of environmental parameters to accompany ecological assessments and experiments by the USGS and other collaborators.

The additional sensors in combination with USGS field research will support the development of bleaching and other coral disease models that will contribute to the validation of NOAA remote sensing techniques.

Specifically the following activities are proposed:

- HotSpot analysis resolution (now at 50km globally) will be upgraded to ~9km, improving spatial detail for local monitoring efforts.
- Maximum monthly mean SST climatologies, now used to determine HotSpot anomalies, will be upgraded using 9km Pathfinder SST climatologies.
- Coral reef bleaching alerts will be automated directly from the HotSpot and CREWS station indices.
- Coral reef bleaching observations will continue to be collected via e-mail, web form, and field-based observations.
- CREWS stations installed during 2000 in the Bahamas and Virgin Islands will be upgraded to include nutrient, pCO_2 and possibly other pollutant indicator sensors.
- Additional CREWS stations will be installed over the next five years to provide representative *in situ* data at 19 domestic reefs. These will all be maintained and utilized by NOAA and USGS.
- At selected sites, USGS will conduct research on key reef processes such as coral recruitment and calcification utilizing video monitoring and the SHARQ technique.
- Data management and data accessibility will be expanded.

Figure 4. *Site of planned CREWS station at St. John, Virgin Islands.*

SUMMARY. The response to global coral monitoring efforts affirms the utility and local relevance of products. NOAA and USGS efforts will continue to transition satellite products to operational status and expand *in situ* validations and field research from the existing five to approximately 20 key and diverse domestic sites by 2006.

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